



EUROPEAN SOUTHERN OBSERVATORY

Organisation Européenne pour des Recherches Astronomiques dans l'Hémisphère Austral

Europäische Organisation für astronomische Forschung in der südlichen Hemisphäre

LA SILLA OBSERVATORY

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La Silla Instrumentation
SOFI EMERGENCY OPERATING
PROCEDURES MANUAL
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Doc.No. LSO-MAN-ESO-63103-0001

Issue 1.2

Date 21/04/2004

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Name Date Signature

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Released.....Ueli Weilenmann.....
Name Date Signature

Change Record

Issue/Rev.	Date	Section/Page affected	Reason/Initiation/Document/Remarks
1.2	21/04/04	All	Fonts and Format corrected.
1.1	25/03/04	All	Document translated to CMM.
1.0	24/03/04	All	Creation

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1 INTRODUCTION

1.1 PURPOSE

This manual shall be a working document which contains in a condensed form all the information which is required by the technical staff to operate the instrument in a save way.

- Cryogenic Emergency Recovery Procedures
- Mechanical Operating Procedures
- Rotator / Co-Rotator Interlock Recovery

It will be updated whenever necessary and a copies shall be attached to the Cabinet door of the SOFI Control Cabinet and distributed to the technical and operations staff.

1.2 APPLICABLE DOCUMENTS

The following documents, of the exact issue shown, form a part of this document to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this document, the contents of this document shall be considered as a superseding requirement.

[1]	N-MAN-ESO-300-091	Issue 1.0	SOFI HW Manual (JBR)
[2]	VLT-INS-97/0142	Issue 1	SUSI/SOFI Handling Procedures (JLL)
[3]	LSO-MAN-ESO-63103-0002	Issue 1.0	SOFI Maintenance Manual (not yet publ.)

1.3 REFERENCE DOCUMENTS

The following documents are referenced in this document.

[4]	VLT-MAN-ESO-...-...	Draft	VLT Cabinet Cooling System, User Manual
[5]	LSO-MAN-ESO-63103-002	Issue 1.1	Defrost Device for SOFI Window, Tech. Manual

1.4 ABBREVIATIONS AND ACRONYMS

CCC	Close Cycle Cooler: The Leybold equipment consisting of: Compressor on the floor and Cold Head mounted on the vessel
LN ₂	Liquid Nitrogen
Pre-Vacuum Pump	The rotary pump standing on the SOFI platform.
TMP	Turbo Molecular Pump: The pump is mounted on the vessel, and the electronic control is mounted on the side of the SOFI platform.
TMP Valve	The valve attached to the TMP, where the pre-vacuum pump is connected to.
UPS	Un-interruptible Power Supply

Explanations:

Who may do what? The following groups are authorized to do the interventions as indicated in the respective procedures:

LIN	Infrared	①
NTTT	NTT Team	②
LIN	Optical Detectors	③
MEC	Mechanics Team	④
All	from any team	⑤
►	Warning	

The following abbreviations and acronyms are used in this document:

LSM	La Silla Management
LSO	La Silla Observatory
N/A	Not Applicable
TBC	To Be Confirmed
TBD	To Be Defined
WG	Working Group

1.5 GLOSSARY**1.6 STYLISTIC CONVENTIONS**

The following styles are used:

bold

in the text, for commands, filenames, pre/suffixes as they have to be typed.

italic

in the text, for parts that have to be substituted with the real content before typing.

teletype

for examples.

<name>

in the examples, for parts that have to be substituted with the real content before typing.

bold and *italic* are also used to highlight words.

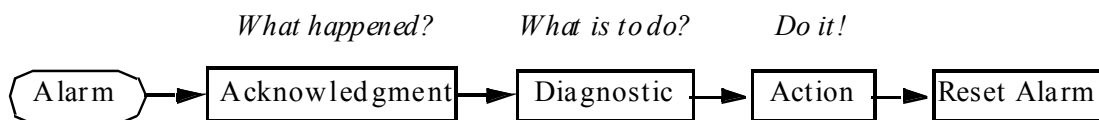
2 CRYOGENIC SAFETY PROCEDURES

Normally, the SOFI OS supplies all the tools to supervise the thermal and cryogenic status of the instrument. The command 'isiStatus &' on 'wsofi' activates a panel, which displays all available information. In case that this tool is not available, it is recommended that the operator checks *at least twice a day*:

- the temperatures (see **Table 3**)
- the vacuum pressure ($<10^{-5}$ mbar on Balzers Vacuum Meter)
- the proper function of the CCC (compressor is running, discharge pressure at ~ 20 bar)

Every emergency action can be divided in three levels:

- Alarm Acknowledgment
- Diagnostic of Alarm
- Recovery Action



Refer to Chapter:

2.0

2.1 - 2.6

3.1 - 3.6

2.0 Diagnostic

When SOFI enters an alarm state, the following steps have to be followed:

1. Read the alarm message on the alpha-numeric alarm display in the control room.
2. Check alarm display in the SOFI instrument room, inside Cabinet #1, see **Table 1**.
3. Acknowledge alarm and reset siren by pressing the right button on the alarm display.
4. Check red status LEDs inside Cabinet #1. Normal operation (COLD) is indicated with a red dot on the label.
5. Note down abnormal system parameters (alarms, values) for later troubleshooting.
6. Proceed according to **Table 2**. and find out witch **CASE #** to follow.

Table 1: Instrument Alarm Indicator

Alarm #	Alarm Indication	Explanation
1	High Pressure	Vacuum Pressure above 10^{-4} mbar
2	LN ₂ Plug & CCC	Plug not placed, or: CCC Failure
3	Cabinet 1 Temp	Over Temperature Cabinet 1
4	Cabinet 2 Temp	Over Temperature Cabinet 2
5	Cabinet 2 Off	Power Failure in Cabinet 2
6	Cabinet 3 Off	Power Failure in Cabinet 3

Table 1: Instrument Alarm Indicator

Alarm #	Alarm Indication	Explanation
7	CCC Failure	Closed Cycle Cooler is not o.k.
8	UPS Alarm	Local UPS for Cabinet #1 is not o.k.

Table 2: Emergency Scenarios

Alarm #	First Sign	Possible Cause	Remedy
1	Vacuum bad Vessel frozen, Ice on Vessel Alarm 'High Pressure'	CCC failure	CASE 2
		Vacuum leak	CASE 1
		Window broken	CASE 1
		Power failure	CASE 3
2	CCC switched off LN ₂ Plug not properly placed	High vacuum pressure	CASE 1
		CCC failure	CASE 2
3	Cabinet Cooling #1 not working	Cooling problem	CASE 5
4	Cabinet Cooling #2 not working	Cooling problem	CASE 5
5	Control Cabinet #2 Off	UPS power failure	CASE 3
6	Control Cabinet #3 Off	UPS power failure	CASE 3
7	Compressor is not running No chirping Noise from Cold Head	Normal power failure	CASE 3
		CCC failure	CASE 2
8	Control Cabinet #1 Off	Cabinet #1 Local UPS failure	CASE 3
other	Vacuum pumps off	Normal power failure	CASE 3
other	Instrument too warm	CCC failure	CASE 2
other	Detector warming up	CCC failure	CASE 2
other	Detector too cold	Cryo controller failure	CASE 4
other	Condensation on Vessel or Window	High Dew Point	CASE 6

2.1 CASE 1: Bad Vacuum

Actions:

1. Find cause of the vacuum deterioration:
 - a. CCC is off: This is not dangerous as such, but after long operation time, a relatively high pressure can build up, as cryo-pumped gas is being sublimated from the cold head.
 - i. If pressure is $>10^{-4}$ mbar ➡ go to step 2.
 - ii. If pressure is $<10^{-4}$ mbar ➡ go to step 4.
 - b. Vacuum leak, indicated normally also by Temp. Alarm 3 ($\Delta T > 10$ K)
 - i. If leak can be repaired ➡ go to step 2.
 - ii. If leak is not found ➡ go to step 2. and also perform Action '3.5 Warming Up Instrument' ❶
 - c. Vacuum brake-down
 - i. Window rupture ➡ perform Actions '3.1 Pumping Vacuum' ❶❷ and then '3.5 Warming Up Instrument' ❶

- ii. Vessel is covered with ice, or ice is starting to be formed on the vessel surface (due to heat convection at vacuum pressures of $>10^{-2}$ mbar) ➡ perform Actions '3.1 Pumping Vacuum' ❶❷ and then '3.5 Warm Up Instrument' ❶
- 2. Proceed with action '3.1 Pumping Vacuum' ❶❷ *immediately!*
- 3. Wait until vacuum has reached $<10^{-4}$ mbar
- 4. Start CCC again (see: 3.2) ❶❷
- 5. Switch on 'DETECTOR COLD' (see: 3.6) in Cabinet #2 to resume temperature control of the detector ❶❷
- 6. Shut down pumps (see: 3.1.2) ❶❷

2.2 CASE 2: CCC Failure

Actions:

- 1. Find cause of the CCC failure:
 - a. Power cut ➡ go to step 2.
 - b. Alarm 'CCC PRESS' on compressor front panel: Low discharge pressure of compressor ➡ Consult CCC manual and charge compressor with high purity He gas ❶
 - c. Alarm 'CCC TEMP' on compressor front panel: Overheating of compressor ➡ Check cooling of compressor ❺
 - d. Alarm 'LN2 plug' in Cabinet #1: Plug not properly placed ➡ Put it back into place ❶❷
- 2. Start CCC again (see: 3.2) ❶❷

2.3 CASE 3: Power Cut

Actions:

- 1. Find cause of the power cut:
 - a. NTT UPS failure ➡ Check circuit breakers on NTT UPS distribution panel ('Estabilizado') and inside of Cabinets #1 and #2 ❶❷
 - b. Normal power cut ➡ Check circuit breakers on NTT distribution panel ('Normal') and inside Cabinet #1 ❶❷
 - c. Cabinet #1 UPS failure ➡ Check UPS and if required connect Cabinet #1 to NTT UPS ('Estabilizado') ❶❷
 - ➡ **Watch out:** A power cut of Cabinet #1 also cuts the supply of Cabinet #3. In this case, Cabinet #3 has to be switched on again manually.
- 2. If power cut is only short (<5 min. approx.) proceed with '3.2 CCC operation' ❶❷ to re-activate the CCC.
- 3. After power has been re-established:
 - a. If the power cut has been long (>5 min. approx.) and the vacuum pressure is high ($>10^{-4}$ mbar), proceed with '3.1 Pumping Vacuum' ❶❷ as the vacuum can deteriorate very fast and considerably.

- b. Decide, whether the instrument has to be warmed up or if it can be cooled again with the CCC alone. Normally, at temperatures of <100K, the CCC is capable of cooling alone the instrument back down again, but it may take its time (up to 72 h)
 - c. If the power cut is very long and the temperature is above 100K (Collimator Lens Temp.), additional LN₂ cooling may be necessary to shorten the cool-down time.
 - d. If any alarm condition persists, try to find out what the cause is. In some cases it will be necessary to power cycle the ESTERS temperature scanner to reset the alarms.
4. Press ‘DETECTOR COLD’ push button on control panel of SOFI Cabinet #2.
 5. Verify that Cabinet #3 is also switched on again.

2.4 CASE 4: Temperature Problems

Actions:

1. Find cause of the temperature problem:
 - a. Cryo controller failure ➡ refer to Conductus LTC-10 manual ❶❷
 - b. Sensor problem ➡ switch over to spare silicon diode sensor on LTC-10 ❶
 - c. Pt100 Sensor Problem ➡ connect spare Pt100 sensor in Cabinet #2 ❶
 - d. Detector heater problem ➡ check wiring to vessel and measure heater element resistance (~2Ω) inside vessel.❶
2. If problem can be solved, proceed with ‘3.7 Cooling down Instrument’ ❶
3. If problem could not be solved, decide if instrument has to be pumped and warmed up.❶

The ESTER DC24 Temperature Scanner can be used ❺ to display the Pt100 temperatures. For trouble-shooting these readings are most important. They are logged also into the ICS and they can be plotted using the RTAP report and history tools ❺. See **Table 3**

- ➡ **Do not press** the key ‘**PROG**’ on the ESTER front-panel! This could activate the alarms and the instrument could switch to warm-up. To recover from any such situation follow CASE 1.
- ➡ In case of persisting problems after a power failure (i.e. alarms that remain active), do a power cycle on the ESTER scanner to reset these alarms.

To read the temperature values on the ESTER scanner, press desired channel ‘#’ and then ‘Enter’. To step to the next channel press ‘+/-’.

Table 3: Temperature Scanner Values

Channel	Sensor	Normal Range when COLD	Unit
1	Pre-Cooling	70.0 - 85.0	K
2	Camera Unit	65.0 - 80.0	K
3	Radiation Shield	90.0 - 115.0	K
4	Collimator Lens	65.0 - 80.0	K
5	Collimator Structure	65.0 - 80.0	K
6	Filter Wheel Unit	65.0 - 80.0	K
7	Sorption Pump	130.0 - 160.0	K
8	Aperture Wheel	65.0 - 80.0	K
9	Ambient Temperature	0.0 - 20.0	°C
10	Diff. between Amb. & Vessel Surface	0 - 5.0	°C

Table 3: Temperature Scanner Values

Channel	Sensor	Normal Range when COLD	Unit
11	not used	-	-
12	Instrument Pressure (4-20 mA)	~ 15 *	mA

* Remark: 4 mA corresponds to atmospheric pressure and 20 mA to good vacuum (10^{-8} mbar). The reading on the Balzers indicator may differ from the value that is displayed on the isiStatus panel, because an algorithm on the analog output is used for the display of this value in the ICS.

2.5 CASE 5: Cabinet Cooling Problem

Actions:

1. Check if cooling water supply is o.k. (2 - 4 bar on Manometers on cooling water manifold on the floor near the rotator cabinet). If there is no coolant flow and the feed line is warm, the specialist for the maintenance of the cooling plant ④ has to be contacted.
2. Cooling problems may also occur when the outside temperature is extremely high, and the cooling needs cannot be satisfied any more. Open the cabinet doors and get help from MEC. ⑤
3. Check the proper operation of the heat exchangers in the cabinets. ①②

2.6 CASE 6: High Dew Point

In July '99 the Window Defrost Device has been installed, and should prevent humidity to condensate on the SOFI window. Please refer to the Technical Manual [6].

Actions:

1. Check the readings dT, Td, rH and T on the Vaisala humidity sensor outside of Cabinet #3. The readings of dT indicates the margin in degrees between window temperature T and dew point.
2. Check inside Cabinet #3 if the Omega Defrosting Controller is active. If dT (the process value PV) is lower than the set-point value (SP), the heater fan should be activated.

This defrost device is ready all the time, but despite that, it is strongly recommended to follow the actions described below:

Actions:

1. Check Reading of the relative humidity on the Meteo Monitor. If the trend is going towards higher humidity and reaches 70 - 80%, as the case when a bad weather front arrives, proceed with 2. Otherwise go to 5.
2. Take the rH% reading on the humidity sensor attached to Cabinet #3.
3. If the reading on Cabinet #3 approaches 80% of relative humidity, switch off the two air handling units in the instrument room to stop further cooling of the room.

➤ In extreme cases, also the vessel could get wet. This has to be prevented in any case.
4. Keep the air handling units switched off until the outside relative humidity drops at least below 80%rH.
5. Resume operation of the air handling units only next morning, after making sure that the humidity problem has vanished.

3 DESCRIPTION OF ACTIONS

3.1 Pumping Vacuum

The pump system can be put into operation at any time, provided the Rotator is disabled. ①②

This includes also that the instrument can be pumped when it is cold. The TMP provides sufficiently good vacuum pressure and this vacuum is oil-free. Therefore no risk of contaminating the cold optics and detector does exist.

3.1.1 Start-up Procedure:

1. Put the Rotator into 0° position (Calibration sphere at 12.00 h)
2. Turn key in SOFI Cabinet #1 to disable the Co-Rotator and Rotator.
3. Move the pre-vacuum pump close to the SOFI vessel.
4. Connect the flexible vacuum hose to the TMP valve after removing the DN25KF blind flange. Don't forget to put the vacuum seal back between hose and valve flange and watch out that hose and seal are properly placed before tightening the clamp.
5. Switch on the pre-vacuum pump by pressing 'PREVAC PUMP' on the control panel of Cabinet #1. The Alarm LED 'Prevac bad' should go out after some seconds, if not, check the vacuum connections!
6. Connect the cable from the TMP control electronics to the TMP
7. Switch Power ON on the control electronics of the TMP
8. Press 'Start' on control electronics of the TMP and wait for the TMP to accelerate to full speed The green LED 'Accelerating' is on. Check Rotation meter, it should indicate a constant speed increase until the green LED 'Normal Operation' goes on.
9. Open now the TMP valve by pressing the button 'TMP VALVE' on the control panel of Cabinet #1.
 - This function is interlocked with the pre-vacuum pressure and the TMP 'Normal Operation' status. Never try to open the TMP valve when proper operation of the pumps is not evident, or vacuum connections are not properly done.
10. Pump until vacuum pressure reaches at least 10^{-4} mbar. Normally one can reach a pressure down to $<10^{-7}$ mbar without problem.

3.1.2 Shut-down Procedure:

- Do **not** shut-down the pumps in the following cases:
 - When the instrument has not yet reached a temperature of >283 K (is not yet warmed up completely)
 - When the CCC is not yet running and therefore does not cryo-pump the instrument.
1. Close the TMP valve with the TMP still running (This is allowed, as the TMP can cope without the pre-vacuum pump for some minutes. It simply compresses the gas against the small volume between pump and valve.)
 2. Shut down the TMP by pressing 'STOP' on the TMP control electronics
 3. Wait until the yellow LED 'Brake' goes off
 4. Switch the power of the TMP control electronics OFF
 5. Disconnect the cable to the TMP control electronics

- You must **never disconnect** this cable while the TMP has not come to a complete halt. This could damage the TMP.
- 6. Shut down the pre-vacuum pump
- 7. Disconnect the vacuum hose and attach the blind flange DN25KF again to the TMP valve.
 - Do not panic: A sucking noise is normal when removing the hose, because the pre-vacuum is maintained when switching off the pre-vacuum pump.
- 8. Remove the pre-vacuum pump to the former place on the platform and cover the hose with the plastic cap.
- 9. Check for clearance between SOFI, Co-Rotator and any other object (pumps, cables, LN₂-dewars, etc.) located on the platform.
- 10. Enable the Co-Rotator by turning the key in SOFI Cabinet #1
- 11. Put the Rotator back into the normal position (calibration sphere at 03.00 h) and check that the Co-Rotator follows smoothly when rotating SOFI.

3.2 Operating CCC

The controls for the CCC are found in SOFI Cabinet #1. ❶❷

1. Check that temperatures of the instrument are still o.k. (< 130K)
2. Switch on CCC by pressing button ‘CCC’
 - If any alarm is still active, the compressor cannot be started remotely from Cabinet #1. In this case try first to remove the alarm condition. If this is not possible and the CCC has to be started *under all circumstances*, remove the remote control (Fernbedienung) cable from the front panel of the compressor and operate the compressor manually.
 - The alarm condition ‘CCC Failure’ will remain or become active. This will be the remainder to reconnect the remote control cable, once the system has been brought into normal operating conditions again.
3. Check that compressor is running and the discharge pressure is at ~20 bar
4. Verify that the temperatures are decreasing.

3.3 Regenerating Sorption Pump

This is a normal maintenance operation ❶, the procedure is described in manual [4]. It is however recommended to regenerate the sorption pump as soon as possible after a vacuum brake-down, as in this case the sorption trap will be saturated. This may be done with the instrument warm or cold.

The regeneration procedure may only be done when:

- The pumps are operating and the instrument is pumping
- The detector has been warmed up

3.4 Warming Up Detector

In any of the following cases the detector will be automatically warmed up:

- High vacuum pressure
- Temperature Alarm 2 (Colt Structure >130 K)

If the detector has to be warmed up manually, proceed as follows: ❶

1. Select ‘DETECTOR WARM’ push button on control panel in Cabinet #2

2. Wait with any other operation until the detector temperature has reached at least 80 K

3.5 Warming Up Instrument

This procedure is described in the manual [4], but it can be also the consequence of an emergency recovery. ❶
The instrument *has* to be warmed up in the cases of:

- Rupture of the window or complete vacuum brake-down (Ice is forming on the vessel, or instrument is completely covered with ice).
- CCC failure which requires servicing of either the compressor or the cold head, and therefore an extended period without cooling is to be expected.

3.6 Cooling Down Detector

Recovery in case of emergency warm-up of the detector in the following cases:

- High vacuum pressure ($>10^{-4}$ mbar)
- CCC off

Procedure: ❶❷

1. Make sure that the vacuum has reached a stable value at around 10^{-6} mbar and that the instrument temperatures are normal.
2. Press 'DETECTOR COLD' push button on control panel of SOFI Cabinet #2.
3. Check that the cryo controller is active and keeps the detector temperature at 65K

If the detector has been kept at ~ 100 K, it will last approx. 1 hour until it reaches 65K.

3.7 Cooling Down Instrument

If the instrument is completely warm, follow the instructions in manual [4]. The cool-down procedure is not intended to be an emergency recovery and therefore it should be handled the normal way ❶. Cool-down also implies, that successful testing of the detector and associated systems has been performed before ❶.

If the instrument has warmed up only slightly, but is still below 100K (Collimator Lens Temp.), recovery of the temperature with the CCC alone is possible, just wait for the temperature to stabilize. However, this may take up to 72 hours.

4 CO-ROTATOR INTERLOCK RECOVERY

According to the instructions given in chapter 5.6 of manual [2] page 56 to 59. The Co-Rotator interlock *always* disables the NTT rotator, to prevent the cables, hoses, fibres and He-lines from being damaged.

- When the rotator is moved by hand, care should be taken that the misalignment is not too large, to prevent damage of the cables and lines.

Therefore move the rotator *slowly and gently!*

If the Co-Rotator is disabled, the brake of the rotator cannot be operated manually. If this is required despite the interlock being engaged, somebody from the INC or NTT team should be consulted to assist you to override this interlock on the rotator and to actuate the brake. **①②**

4.1 Diagnostic

The following **Table 4.** shows the Co-Rotator interlocks and the last column indicates the corresponding action to be taken:

Table 4: Co-Rotator Interlock Indicator

Alarm #	Alarm Indication	Explanation	Remedy
1	Upper Limit 5 Deg.	Out-of-Range +5°	CASE 1
2	Lower Limit 5 Deg.	Out-of-Range - 5×°	CASE 1
3	Manual Stop	Manual Stop Key is active	CASE 2
4	Coupling Disengaged	Master-Slave Axis not (correctly) installed	CASE 3
5	Turbo-Molecular Pump	TMP or Pre-Vacuum Pump connected	CASE 4
6	End-of-Travel +270 Deg.	HW Limit reached at +270°	CASE 5
7	End-of-Travel -270 Deg.	HW Limit reached at - 270°	CASE 5
8	Power Supply	3-phase Power: One ore more Phases off	CASE 6

4.2 CASE 1: Limit +/- 5 Deg.

Recovery Action: **①②③**

1. Open the alarm indicator panel in Cabinet #1 (2 screws) and flip down the panel.
2. A DIN module (PCB2) can be found in the right corner on the backside of the panel. A red LED is lit on the controller left of the switch insdie this module. The co-rotator can be moved out of the limit by pressing this switch in one or the other direction (the velocity can be adjusted with the knob to the right side of the switch, initially it should be set to 2-3). The red LED will go out, as soon as the co-rotator is back inside the +/-0.5° range.
3. Check that the interlock indicator on the front panel is off.
4. Flip the panel back up and fix the screws again.

4.3 CASE 2: Manual Stop

Recovery Action: **⑤**

1. Put the manual stop key from position 'Co-Rotator STOP' into the position 'Co-Rotator ON'.
2. Check that the interlock indicator on the front side is off.

4.4 CASE 3: Master-Slave Problem

Recovery Action: ❶❷

1. Stop the co-rotator with the manual stop key
2. Re-attach coupling
3. Check that the interlock indicator on the front side is off now
4. Check that co-rotator and rotator are properly aligned. This can easily be seen on the two opposite cable arms: the two arms from SOFI and the co-rotator must face each other and the cables must go straight from one arm to the other.
5. If required adjust potentiometer zero position ❶
6. Enable manual stop key

4.5 CASE 4: TMP or Vacuum Line

Recovery Action: ❶❷

1. Disconnect the cable from the TMP or remove the pre-vacuum line from the TMP valve.
2. Check that the interlock indicator is off

4.6 CASE 5: End-of-Travel +/- 270 Deg.

This Action applies also for recovery from second level interlock +/- 6° co-rotator misalignment.

Recovery Action: ❶❷

1. Stop the co-rotator with the manual stop key
2. Check that co-rotator and rotator are properly aligned. This can easily be seen on the two opposite cable arms: the two arms from SOFI and the co-rotator must face each other and the cables must go straight from one arm to the other.
3. Align rotator and co-rotator manually if necessary.
 - As the rotator will be disabled from the co-rotator interlock condition, the interlock override switch in the rotator control cabinet has to be actuated for this operation, in order to disengage the rotator brake. ❶❷
4. Open the alarm indicator panel in Cabinet #1 (2 screws) and flip down the panel.
5. Temporarily bridge the relay contacts 11 and 14 of the relay that has caused the interlock (the one with the yellow LED in-active, of either RE 121 or RE 122)
6. Manually move the rotator out of the HW limit (the co-rotator should follow). See remark in 3.
7. Remove the bridge on relay contacts 11 and 14
8. Enable manual stop key again and check that the interlock indicator is off
9. Put the interlock override switch in the rotator control cabinet back to normal

4.7 CASE 6: Power Supply

Recovery Action: ❶❷

1. Re-establish all three phases of the 3x400 VAC power supply.
2. If required, call an electrician.
3. Check that the interlock indicator is off

5 DIS-MOUNTING AND MOUNTING OF SOFI / SUSI 2

This procedure is subject to modifications, once the documentation [3] from JLL is available.

Required Material:

- Crane
- Support Jack for the SOFI structure / SUSI flange
- Centre slide
- Support structure with yellow crane hook attached to it and left-side post.
- Reduction gear box
- Screws, wrench and normal Allen keys plus long Allen Keys 6 and 8.

If SUSI has to be serviced at the same time as SOFI is being retracted, it may be necessary to disconnect and dismantle the following elements:

Disconnect all cables, fibres and cooling hoses between SOFI and SUSI. FIERA has to be disconnected by ODT ③. The rotator has to be aligned to the proper positions by hand. Be careful as the rotator will not be balanced anymore, as soon as elements are being dismantled.

1. Disconnect the FIERA boxes
2. Disconnect the SUSI shutter cable
3. Remove the coolant hoses
4. Disconnect and dismantle PULPO
5. Disconnect the 2 motor cables to the M4 and Filter Wheel functions
6. Disconnect the optical fibres
7. Disconnect the coax cable (LAN to calibration unit LCU)
8. Dismount the 2 FIERA electronic boxes with the crane.
9. Dismount the SUSI cryostat with the crane.

5.1 Installation of Service Gear

Procedure: ①②④

1. Put the Rotator into 0 ° position (Calibration sphere at 12.00 h). Exact Value: -0.383215 °
 - If the Rotator is not properly balanced it will be difficult to move it to that angle by remote control. In this case it has to be properly positioned by hand. (see 4.d. below)
2. Engage the NTT emergency button on anyone side of the Rotator.
3. If only the SOFI Cryostat (without structure) shall be removed proceed to point 5.
4. Install the support jack on the middle rail under the SOFI structure:
 - a. Install the slide with the support jack and the wedge on the middle rail, but without the threaded hook. Be careful that no balls are being lost! If this is the case: re-insert them.
 - b. Push the jack underneath the SOFI structure
 - It may be necessary to disengage the Rotator brake in order to push the support jack properly into the final position.
 - If the rotator brake cannot be actuated, the by-pass switch has to be actuated inside the rotator cabinet! Ask an electronics specialist from the NTT team for assistance. ①②
 - c. Engage the threaded hook from above into the slit on the wedge that is mounted on the SOFI structure (at 18.00 h pos.)

- d. Join the spindle and the thread in the hook through the hole in the wedge.
 ► Again: It may be necessary to disengage the Rotator brake in order to properly screw in the spindle into the hook.
- e. Tightly turn the spindle clock-wise to support the weight, until the cursor is reaching the mark 'SOFI' (=SOFI only) or 'SUSI' (=SOFI+SUSI), depending on the intended intervention
- f. Tighten the clamp on the right side of the jack
5. Turn key to 'Co-Rotator OFF' in SOFI Cabinet #1 to disable the Co-Rotator and Rotator.
6. Dismount the master/slave axis between SOFI and Co-Rotator:
 - a. Remove the 3 shells of the protective cover (Allen Key #2)
 - b. Remove bellow on SOFI side by loosening the 2 screws (Allen Key #2.5) and retract it towards the co-rotator
 - c. Loosen bellow on Co-Rotator side (Allen Key #2.5)
 - d. Remove axis by disengaging it first on the SOFI side
7. Install the slide with the bolt (fixation point) on the middle rail
8. Dismount the left post from the support structure (4 screws M16x40)
9. Dismount the reduction gear box from the support structure (4 screws M12x40)
10. Install the support structure for SOFI, attached to the yellow arm, using the crane and approaching SOFI from the right-hand side:
 - a. Engage the structure onto the sliders by carefully positioning the screws on the sliders first and then lowering it with the crane.
 - b. Watch out that the bolt on the central slider is properly engaged with the spindle drive arm.
 - c. Fix all 16 screws (M8x80) on both sides.
 - d. Remove the 4 screws (M10x80) to dismount the yellow arm and park the crane.
 - e. Push the support structure on the rails towards SOFI. Take care with the cable arms.
11. Install the reduction gear on the support structure
 - a. Seat the reduction gear onto the support post such that it touches the reference stop.
 - b. Attach the flange of the reduction gear to the flange of SOFI.
 - c. Insert the 4 screws (M12x40) with washers to secure the gear. Be sure that it touches the reference stop.
 - d. Insert all 12 hex screws (ten M8x30 and two M8x25) and fix them with a 13mm wrench
12. Proceed on the other side by loosening the two M5 screws which fix the bearing to the cabinet structure on the left side of SOFI:
 - a. Install the left post onto the support structure with its inclined top surface facing the telescope. Insert the top first from underneath SOFI
 ► Be careful not to damage the connectors!
 - b. Insert 4 screws (M16x70) on the bearing and the 4 screws (M16x40) on the structure to keep both parts in place, do not tighten yet.
 - c. Insert the M10 screw in the slit on the top of the left post and screw it into the bearing support.
13. Push the top of the post into the direction to the telescope by using the screw engaged in the bearing support (M10). Use the spindle drive on the fixation point to move the structure and clamp it.
14. Tighten all 4 screws (M12x40) of the gear box on the base plate. Fix the 4 M16 screws on lower end of the post and then the 4 M16 screws on the bearing.
15. Check that the structure is well in place and that all screws are tightened.

5.2 Dismounting the SOFI Vessel only (without SUSI and the Structure)

With this procedure, only the SOFI vessel will be dismounted, i.e. to open and intervene SOFI ❶.

1. Make sure that the support structure is properly mounted (see 3.1)
2. Make sure that all cables, fibres and cooling hoses between SOFI and SUSI. FIERA have been disconnected by ODT ❸.
3. Loosen the vertical axis of the cable arm fixations to enable the cable arms to fold when SOFI is being retracted.
4. Unfasten the M12 screws which fix SOFI to the structure.
5. Retract the instrument on the rail, either by pushing it by hand, or by using the central fixation point and the spindle, don't forget to loosen the clamp.
6. Once retrieved, fix the safety screws on both sides of the structure, to prevent the instrument from moving accidentally.

5.3 Retracting SOFI including the Structure (withot SUSI)

Following this procedure the SUSI flange will remain attached to the Rotator and SOFI including SOFI structure will be retracted, i.e. to service SOFI or to get access to SUSI2. As the structure is very heavy, the front part has to be supported by the support jack on the center rail.

Procedure: ❶❷❹

1. Make sure that the support structure is properly mounted (see 3.1 and 3.1 point 6.)
2. The cursor on the support jack has to be on position 'SOFI'.
3. Loosen the vertical axis of the cable arm fixations to enable the cable arms to fold when SOFI is being retracted.
4. Make sure that all cables, fibres and cooling hoses between SOFI and SUSI. FIERA have been disconnected by ODT ❸.
5. Loosen all screws **B** (white) and **C** (red). Do *not* open yellow screws **A**!
 - Before starting to un-screw the instrument study carefully Chapter 3 in [3].
 - **Removing the wrong screws may result in a disaster.**
6. Make sure that *all* screws are removed, as it will not be possible to remove SOFI if even only one screw is left in.
7. Loosen the clamp and carefully retract SOFI from the SUSI flange by moving the spindle clock-wise.
8. Fix the clamps on both sides of the support structure and the clamp on the support jack.
9. If more space is required, the master-slave unit of the co-rotator can be dismounted as well. Refer to [2] and [3] for this operation.

5.4 Retracting SOFI + Structure + SUSI2 + Flange completely

Following this procedure, both SUSI *and* SOFI will be retracted, i.e. to service the adapter or to have access to the TCDDs in the adapter. This procedure applies also when SHARP on DIFA has to be installed. For this operation it is not necessary to dismount SUSI and disconnect its cables.

Procedure: ❶❷❹

1. Make sure that the support structure is properly mounted (see 3.1 and 3.1 point 6.)
2. The cursor on the support jack has to be on position 'SUSI'.

3. Make sure that the LAN cable to the Calibration Unit LCU 'Isocal' is disconnected. And check if there are any other hoses or cables to be disconnected.
4. Loosen the vertical axis of the cable arm fixation to enable the cable arms to fold when SOFI and SUSI2 is being retracted.
5. Loosen all screws **A** (yellow) and **C** (red). Do *not* open white screws **B**! Screws **A** can only be accessed through a hole in the SOFI structure. These screws will not be completely removed.
 - Before starting to un-screw the instrument study carefully Chapter 3 in [3].
 - **Removing the wrong screws may result in a disaster.**
6. Make sure that *all* screws **A** and **C** are removed, as it will not be possible to remove SOFI if even only one screw is left in. Keep an eye on screws **A**, as they are hidden!
7. Loosen the clamps on the support jack and the fix-point.
8. Carefully retract SOFI and SUSI flange by moving the spindle clock-wise.
9. Fix the clamps on both sides of the support structure and the clamp on the support jack
10. If more space is required, the master-slave unit of the co-rotator can be dismantled as well. Refer to [2] and [3] for this operation.

5.5 Re-Installation

Follow the procedures described in 3.2, 3.3 and 3.4 respectively in *reverse* order! ❶❷❸

Take special care:

- To clean the optics inside the adapter before attaching the instrument. ❷
- That the rotator is in the right position (-0.383215°) before re-attaching the instrument.
- That the rotator brake is free at the time the instrument flange is engaging with the centering pins. Use the spindle on the central fixation point to approach the rotator slowly and smoothly.
- Clear the platform and remove all parts of the support structure and handling gear. Special care has to be taken that the **support jack** and the **fixation point are being removed**.
- Reconnect the SUSI, FIERA and PULPO cables and coolant hoses. ❸
- Don't forget to realign the cable arms and tighten them.
- If the master-slave unit has been removed, be careful to mount the unit with the connectors facing down and re-connect the cables properly *before* turning the rotator.
- Test the proper functioning of the co-rotator after all interlocks have been de-activated.

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